

WHAT IS CLAIMED IS:

1. A method for making a lens or lens array, comprising:

 providing a substrate;

 depositing a dielectric layer over the substrate;

 depositing a patterning layer over the dielectric layer;

 removing a portion of the patterning layer overlying an area of the dielectric layer corresponding to a to-be-formed lens;

 removing the exposed portion of the dielectric layer to form a curved recess in the exposed portion of the dielectric layer; and

 filling the curved recess with a lens material.

2. The method of claim 1, wherein the removing comprises wet etching.

3. The method of claim 1, wherein the removing comprises exposure through a grey scale or shadow mask.

4. The method of claim 1, further comprising forming an array of sensor elements over the substrate before depositing the dielectric layer.

5. The method of claim 4, wherein the sensor array comprises an array of CMOS sensor elements.

6. The method of claim 4, wherein the sensor array comprises an array of CCD sensor elements.

7. The method of claim 1, wherein the dielectric layer has a lower index of refraction than the lens material layer.

8. The method of claim 1, wherein the lens material layer is inorganic.

9. The method of claim 4, wherein the sensor elements underlie an array of to-be-formed microlenses.

10. The method of claim 1, further comprising polishing the lens material layer.

11. The method of claim 1, further comprising treating and smoothing the curved recess.

12. The method of claim 1, wherein the interface between the curved recess and the lens material layer has a roughness that is less than the wavelength of visible light.

13. The method of claim 12, wherein the roughness is less than approximately 1/10 the wavelength of the visible light.

14. The method of claim 1, wherein the two removing steps forms a plurality of curved recesses.

15. The method of claim 14, wherein at least one curved recesses has a shape different than the other ones of the curved recesses.

16. The method of claim 1, wherein the curved recess is non-spherical.

17. The method of claim 1, further comprising removing remaining portions of the patterning layer after removing the exposed portion of the dielectric layer.

18. The method of claim 1, wherein the lens is a microlens or non-spherical lens.

19. A lens or lens array device, comprising:
a substrate;
a dielectric layer over the substrate, wherein the dielectric layer comprises at least one curved recess on the upper surface of the dielectric layer; and
a lens material layer over the dielectric layer.

20. The device of claim 19, further comprising an array of sensor elements between the substrate and the dielectric layer.

21. The device of claim 20, wherein the sensor elements are CMOS or CCD devices.

22. The device of claim 19, wherein the lens material has a higher index of refraction than the dielectric layer.

23. The device of claim 19, wherein the dielectric layer comprises an array of curved recesses.

24. The device of claim 19, wherein at least one of the curved recesses is non-spherical.

25. The device of claim 23, wherein at least one of the curved recesses has a shape different than the other ones of the curved recesses.

26. The device of claim 19, wherein the dielectric layer and lens material layer are formed by deposition.

27. The device of claim 19, wherein the lens material layer has a polished upper surface.

28. The device of claim 19, wherein the roughness of the dielectric layer at the interface of the lens material layer is less than the wavelength of visible light.

29. The device of claim 28, wherein the roughness is approximately 1/10 or less of the wavelength of the visible light.

30. The device of claim 19, wherein the curved recess is non-spherical.

31. The device of claim 19, wherein the curved recess forms a microlens or non-spherical lens.

32. A method for manufacturing a lens or lens array, comprising:

providing a substrate;
depositing a dielectric layer over the substrate;
selectively removing a portion of the dielectric layer corresponding to a to-be-formed lens to form a curved recess on the dielectric layer; and

forming a layer of lens material over the dielectric layer.

33. The method of claim 32, further comprising forming a sensor array over the substrate before depositing the dielectric layer.

34. The method of claim 32, wherein the refractive index of the lens material is higher than that of the dielectric layer.

35. The method of claim 32, wherein the to-be-formed lens is a microlens.

36. The method of claim 32, wherein the to-be-formed lens is non-spherical.

37. The method of claim 32, wherein the forming comprises depositing the lens material to fill the curved recess.

38. The method of claim 32, wherein the forming comprises using the dielectric layer with the curved recess as a molding template.

39. A method of forming a molding for making a lens, comprising:

providing a substrate;
depositing a dielectric layer over the substrate;
depositing a patterning layer over the dielectric layer;
removing a portion of the patterning layer overlying an area of the dielectric layer corresponding to a to-be-formed lens; and

removing the exposed portion of the dielectric layer to form a curved recess in the exposed portion of the dielectric layer.

40. The method of claim 39, wherein the to-be-formed lens comprises a microlens or a non-spherical lens.

41. A device for molding a lens or lens array, comprising:

a substrate; and
a dielectric layer over the substrate, wherein the dielectric layer comprises at least one curved recess on the upper surface of the dielectric layer, wherein the curved recess corresponds to a to-be-formed lens.

42. The device of claim 41, wherein the to-be-formed lens comprises a microlens or a non-spherical lens.